2018 Collated Biomolecules and Enzymes (DNA, Gene Expression) STQ

2018 / H2 / AJC PRELIM / P2 Q2

1 Fig. 1.1 shows the effect of pH on the activity of a protease enzyme at the optimal temperature of 37°C.

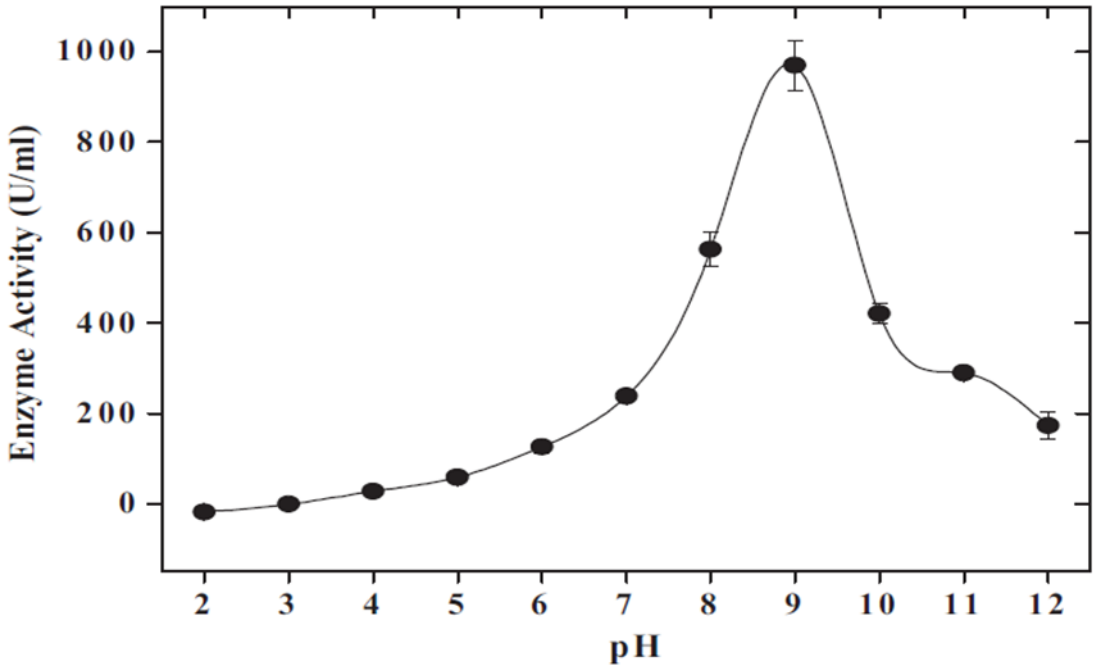

Fig. 1.1

(a) Draw, on Fig. 1.1, the approximate shape of the curve if the same experiment is conducted at 25°C. [1]

(b) Explain with reasons the shape of the curve you have drawn.

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…… [2]

(c) Using information from the graph, explain why proteases stored in vesicles with pH 7.2 cannot break down vesicular membrane proteins and suggest how these proteases can be activated through increase in pH.

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……. [6]

[Total: 9]

2 The synthesis of collagen is shown in Fig. 1.1.

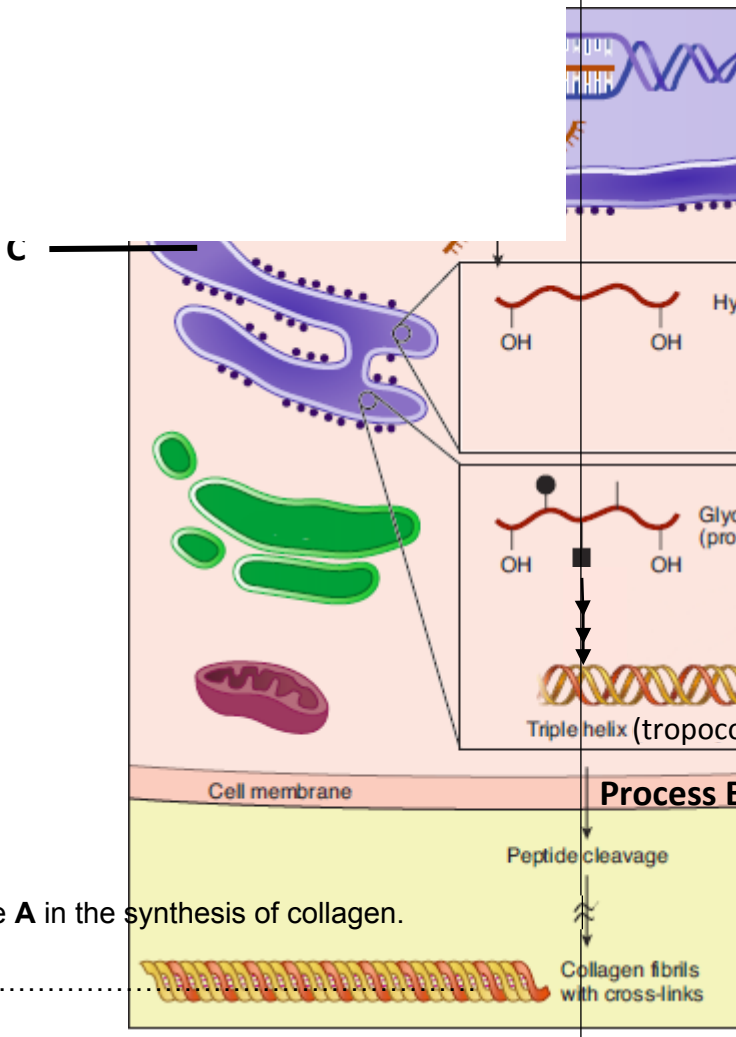

Fig. 1.1

(a) **(i)** Describe two important functions of structure **A** in the synthesis of collagen.

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.....[2]

(ii) Tropocollagen leaves the cell to be assembled to form collagen fibrils via **Process B**. Outline **Process B**.

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……[3]

(b) Suggest how chemical modification such as hydroxylation in organelle **C** results in collagen having a high tensile strength.

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……[2]

Fig. 1.2 shows two electron micrographs. One of the electron micrograph shows part of a normal cell while the other electron micrograph shows part of a cancer cell. The white arrows point to an organelle within the cell. The appearance of this organelle in both cell types were visibly different. The cancer cell had a higher activity than the normal cell.

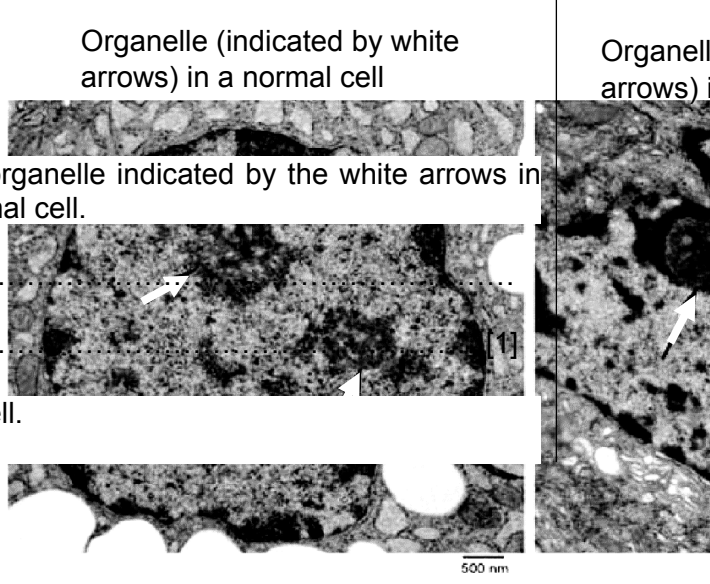

Fig. 1.2

(c) **(i)** Describe the visible difference between the organelle indicated by the white arrows in Fig. 1.2, between the cancer cell and the normal cell.

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……[1]

(ii) Account for the higher activity of the cancer cell.

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……[2]

[Total: 10]

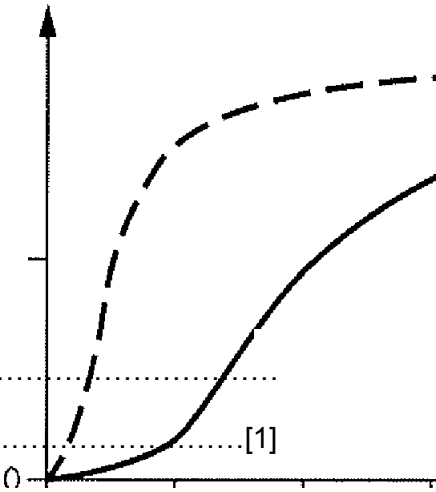
2018 / H2 / EJC PRELIM / P2 Q2

3 The rate of glycolysis is regulated by the action of ATP on the enzyme phosphofructokinase (PFK), the th enzyme in the glycolysis pathway. PFK catalyzes the formation of fructose 1,6-bisphosphate from fructose phosphate and ATP.

A graph of PFK against F6P concentration would exhibit the 'sigmoidal curve' typical of allosteric enzymes.

Fig. 2.1 shows the effect of substrate F6P (fructose 6-phosphate) concentration on the activity of PFK different ATP concentrations. PFK is an allosteric enzyme with a quaternary structure that is inhibited by h levels of ATP. High levels of ADP and AMP will increase activity of the enzyme.

Fig. 2.1



(a) **(i)** With reference to PFK, explain the term '*allosteric enzyme*'.

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……[1]

(ii) On Fig. 2.1, label the graphs which reflect low ATP and high ATP concentrations respective [1]

(b) Enzyme researchers have used a model of allosteric enzyme mechanism called the 'symmetry model'

explain the action of PFK. F6P binds with great affinity only to the active state but not to the inactive sta
Binding of one F6P molecule will progressively shift PFK structure from the inactive state to the active state.

A graph of PFK against F6P concentration would exhibit the 'sigmoidal curve' typical of allosteric enzymes.

(i) Explain how the binding of a molecule like AMP to PFK can increase the activity of PFK.

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……[2]

(ii) The enzymatic mechanism in PFK is similar to that of the oxygen-binding mechanism of the transp
protein, haemoglobin. Sketch the shape of the oxygen binding graph for haemoglobin at increas
concentrations of oxygen in the space below. [1]

(iii) Using your knowledge of the structure of haemoglobin, explain the shape of the graph you drew in
(ii).

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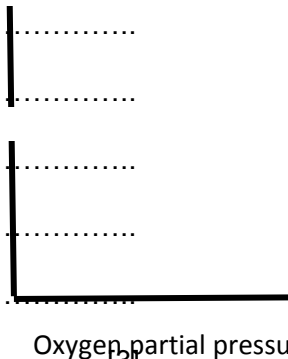
……[3]



(c) Explain the significance of regulation of PFK by ATP to AMP ratios.

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……..[2]

[Total:

2018 / H2 / JJC PRELIM / P2 Q2

4 Fig. 2.1 shows a triglyceride molecule.

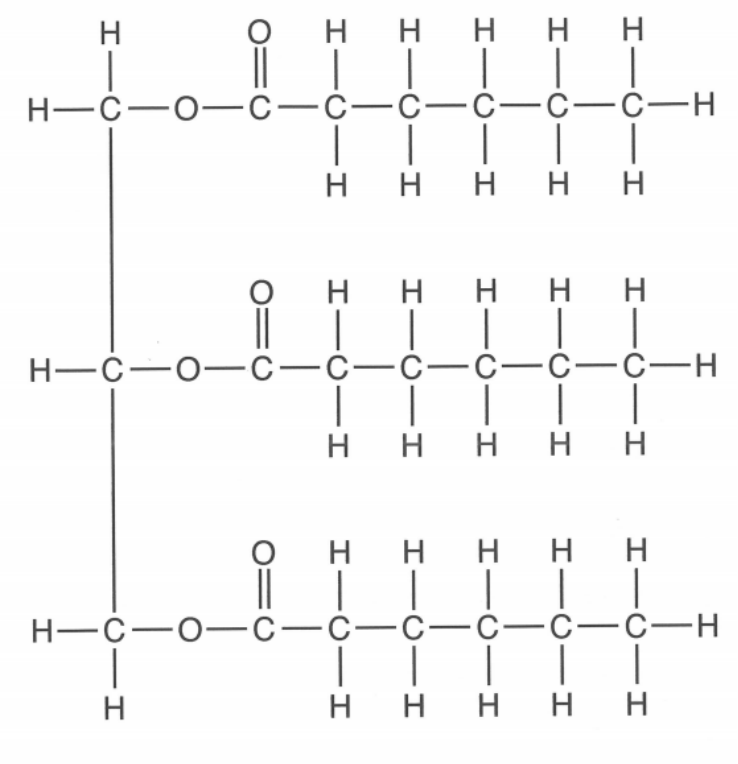

Fig. 2.1

(a) (i) State the names of the two types of molecules that undergo condensation reactions to form a triglyceride. [2]

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(ii) Describe what is meant by a condensation reaction. [2]

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(iii) The triglyceride in Fig. 2.1 is saturated.

Explain how the structure would be different for an unsaturated triglyceride. [3]

(b) The eukaryotic cell surface membrane contains phospholipids, cholesterol and proteins.

(i) Describe how a phospholipid molecule differs from a triglyceride molecule. [2]

(ii) Describe the roles of cholesterol in eukaryotic cell surface membranes. [2]

(c) The respiratory quotient, RQ, is used to show which substrate is being metabolised by cells. It can be determined using the equation below.

$$RQ = \frac{\text{molecules of carbon dioxide released}}{\text{molecules of oxygen taken in}}$$

Lauric acid is a saturated fatty acid found in coconuts and has a chain of 12 carbon atoms.

(i) Complete the equation below which outlines the aerobic respiration of lauric acid. [1]

$C_{12}H_{24}O_2$ + ……. O_2 $\quad 12CO_2 + 12H_2O$

(ii) Calculate the RQ value for lauric acid.

Give your answer to 2 decimal places.

RQ value = ……. [1]

[Total: 13]

2018 / H2 / PJC PRELIM / P2 Q1

5 Collagen is the main structural protein in the human body. It strengthens the tendons and supports the skin and internal organs. Fig.1.1 shows the organization of collagen fibres.

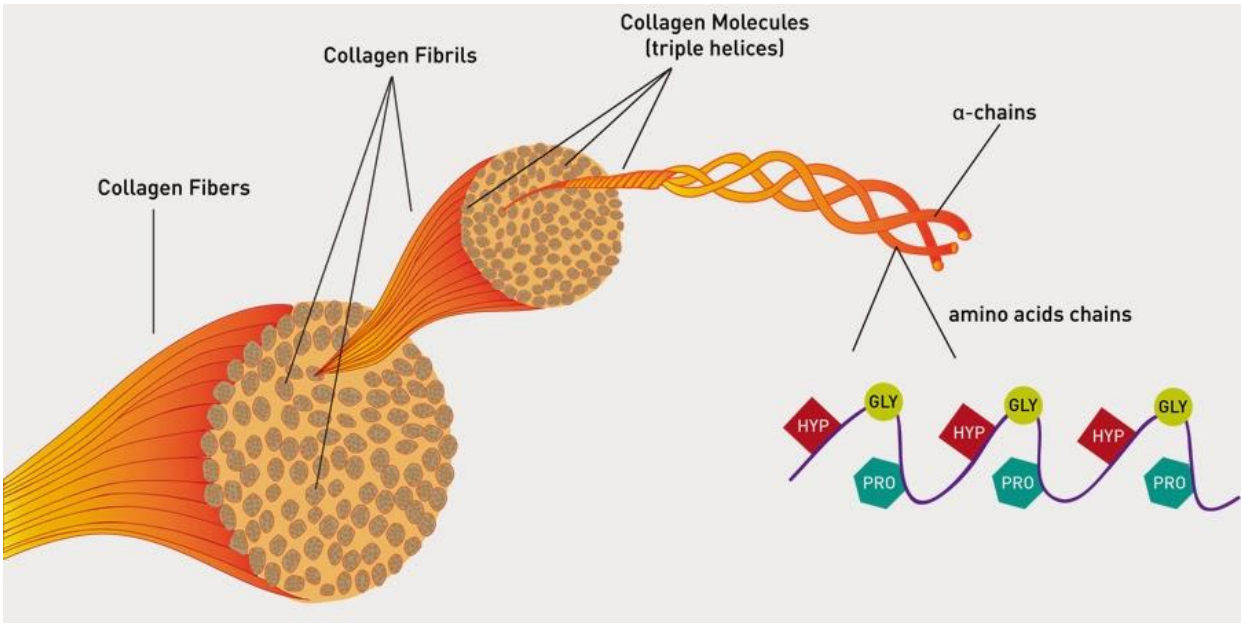

Fig. 1.1

(a) Label structures **A**, **B**, **C** and **D** in Fig. 1.1.

A ……

B ……

C ……

D …… [2]

(b) With reference to Fig. 1.1, describe the bonds involved in the formation of collagen which contribute to its high tensile strength.

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…… [2]

(c) Suggest why the assembly of collagen takes place outside the cell.

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…… [2]

(d) Certain pathogenic bacteria such as *Clostridium histolyticum*, have collagenases which digests collagen tissue of their hosts, causing a form of tissue death known as gangrene.

The action of collagenase can be seen in Fig.1.2, illustrating the specificity of the active site in binding to a segment of collagen and eventually cleaving it into 2 segments.

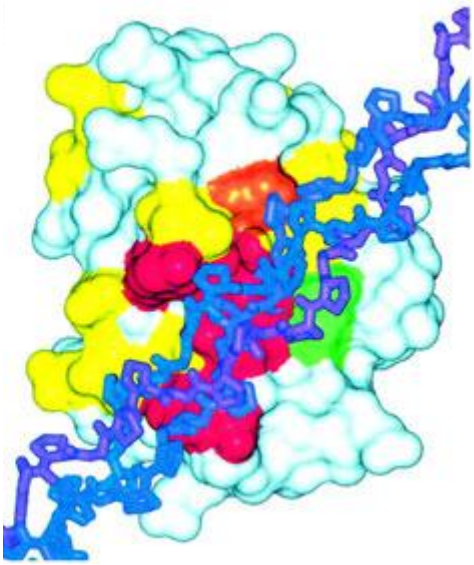

Fig. 1.2

(i) Explain the function of amino acid residues situated at the active site of collagenase.

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…….. [2]

[Turn Over

(ii) A scar is an area of fibrous tissue that replaces normal skin after an injury. All scarring is composed of the same collagen as the tissue it has replaced, but the composition of the scar tissue, compared to the normal tissue, has slightly different arrangement. Scar tissue also lacks elasticity unlike normal tissue which distributes fiber elasticity. The extend of scarring depends on the amounts of collagen expressed at the injury site.

Santyl® Ointment is an enzymatic ointment which contains collagenase. The enzyme collagenase is derived from *Clostridium histolyticum*.

Suggest a therapeutic use of collagenase.

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…….. [1]

[Total: 9]

2018 / H2 / PJC PRELIM / P2 Q2

6 Fig. 2.1 shows an incomplete diagram of the fluid mosaic model of membrane structure. The diagram shows the cell surface membrane of a eukaryotic cell.

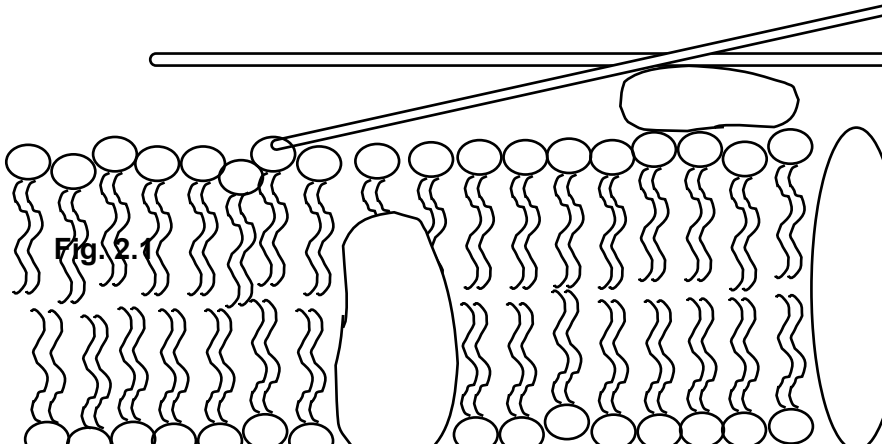

Fig. 2.1

(a) State what is meant by fluid mosaic model.

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…….. [2]

(b) Phospholipids are a type of lipid. Lipids, in general, are made up of glycerol and fatty acids monomers covalently bonded together. Name the covalent bond and describe the breakage of this bond.

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…….. [2]

[Turn Over

(c) List four features of cell surface membranes of eukaryotic cells that are **not** visible in Fig. 2.1. and outline their roles in the cell surface membrane.

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…….. [4]

(d) The inner and outer membrane of the mitochondrion differ in the detail of their membrane components. The inner membrane is also much less permeable than the outer membrane.

Suggest **two** ways in which the structure of the inner membrane is different from that of the outer membrane to produce a **less permeable** inner membrane.

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…… [2]

[Total: 10]

2018 / H2 / RI PRELIM / P2 Q1

7 Phosphofructokinase (PFK) is an allosteric enzyme made of 4 subunits and controlled by many activators and inhibitors which regulate glycolysis. PFK phosphorylates fructose-6-phosphate to form fructose-1,6-bisphosphate.This enables the cell to increase or decrease the rate of glycolysis in response to the cell's energy requirements. For example, a high ratio of ATP to ADP will inhibit PFK and glycolysis.

Fig 1.1 shows the effect of low ATP on phosphofructokinase (PFK) activity.

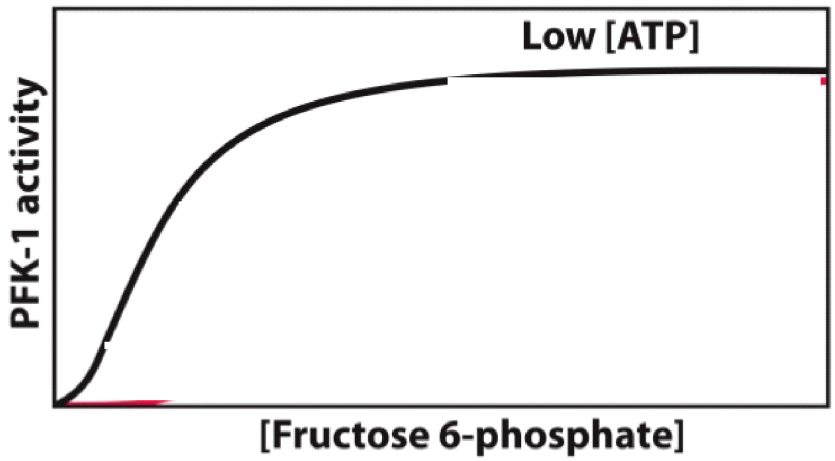

Fig. 1.1

(a) **(i)** On Fig. 1.1, draw a graph to show the effect of high ATP on PFK activity. [1]

(ii) Explain the graph you have drawn.

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…… [3]

(iii) Name a molecule that will act as an allosteric activator of PFK.

..... [1]

(b) Fig. 1.2 shows a PFK molecule.

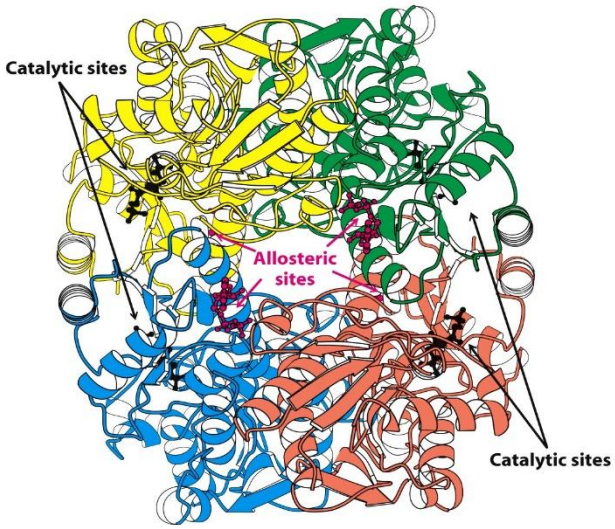

Fig. 1.2

(i) Describe the structure of PFK.

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..... [4]

(ii) Explain how a change in pH may affect PFK activity.

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..... [3]

[Total : 12]

8 Fig.1.1 shows a cell undergoing telophase and process **X** simultaneously.

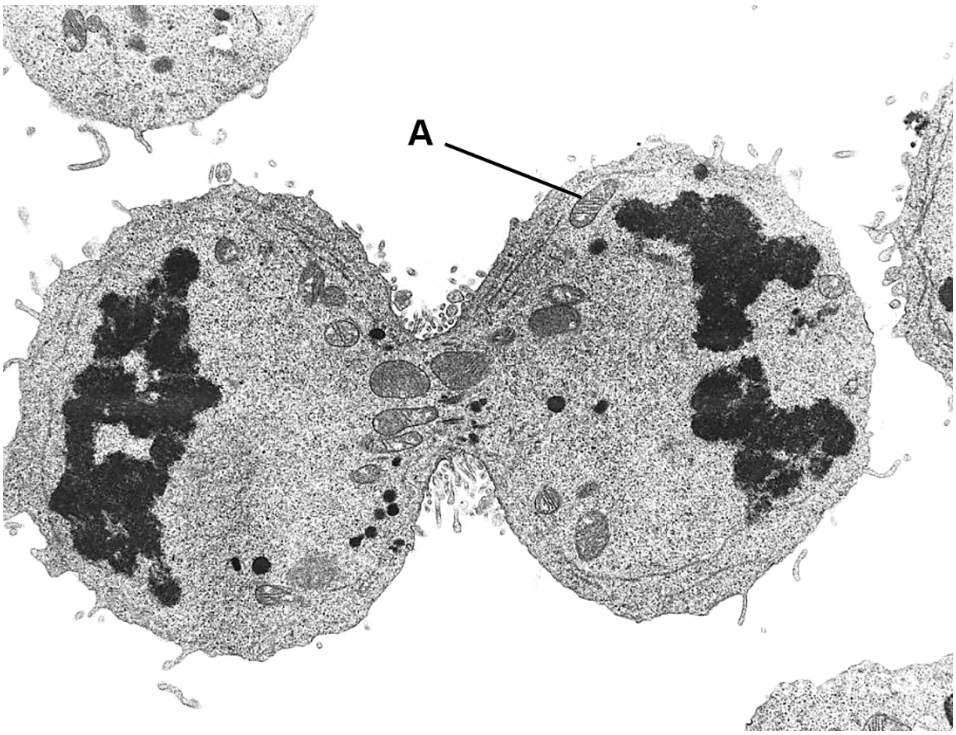

Fig. 1.1

Source: David M. Phillips, 2014

(a) Name structure **A**. [1]

(b) Name process **X** and explain how it supports the cell theory. [2]

(c) Outline the role of **A** and explain its significance to process **X**. [3]

[Total: 6]

2018 / H2 / ACJC PRELIM / P2 Q2